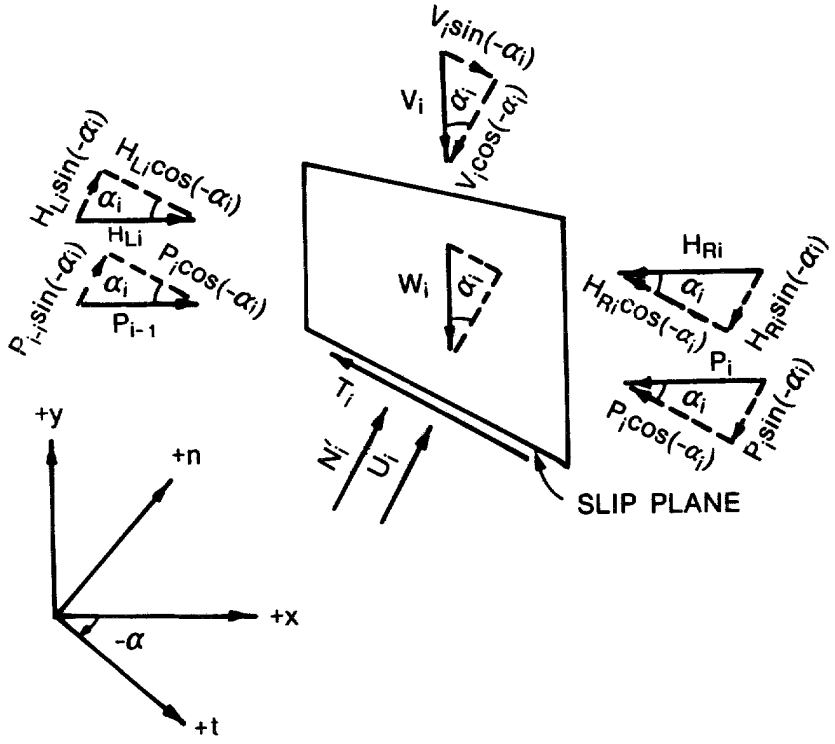
APPENDIX L

DERIVATION OF GENERAL WEDGE EQUATION FOR MULTIPLE WEDGE ANALYSIS

L-1. Free-body diagram. A free-body diagram of an i^{th} wedge is shown below:



Writing equilibrium equations normal and parallel to slip plane,

$\Sigma F_n = 0$:

$$0 = N_i + U_i - W \cos(-\alpha_i) - V_i \cos(-\alpha_i) + H_{Li} \sin(-\alpha_i) - H_{Ri} \sin(-\alpha_i) + P_{i-1} \sin(-\alpha_i) - P_i \sin(-\alpha_i)$$

Using the trigonometric relationships,

$$\cos(-\alpha_i) = \cos \alpha$$

and

$$\sin(-\alpha) = -\sin\alpha$$

$$N_i = (W_i + V_i)\cos(\alpha_i) - (H_{Li} - H_{Ri})(-\sin\alpha_i) - (P_{i-1} - P_i)(-\sin\alpha_i) - U_i$$

$\Sigma F_t = 0$:

$$0 = -T_i + W_i \sin(-\alpha_i) + V_i \sin(-\alpha_i) + H_{Li}\cos(-\alpha_i) - H_{Ri}\cos(-\alpha_i) + P_{i-1}\cos(-\alpha_i) - P_i\cos(-\alpha_i)$$

$$T_i = (W_i + V_i)(-\sin\alpha_i) + (H_{Li} - H_{Ri})\cos\alpha_i + (P_{i-1} - P_i)\cos\alpha_i$$

According to the Mohr-Coulomb failure criterion,

$$T_F = N_i \tan\phi_i + c_i L_i$$

Writing the equation for the sliding factor of safety,

$$FS_i = \frac{T_F}{T_i} = \frac{N_i \tan\phi_i + c_i L_i}{T_i}$$

where FS_i = factor of safety.

Substituting the expressions for T_i and N_i into the equation for FS_i yields

$$FS_i = \frac{\left[(W_i + V_i)\cos\alpha_i + (H_{Li} - H_{Ri})\sin\alpha_i + (P_{i-1} - P_i)\sin\alpha_i - U_i\right]\tan\phi_i + c_i L_i}{-(W_i + V_i)\sin\alpha_i + (H_{Li} - H_{Ri})\cos\alpha_i + (P_{i-1} - P_i)\cos\alpha_i}$$

Solving for $(P_{i-1} - P_i)$,

$$(P_{i-1} - P_i) = \left[(W_i + V_i)(\tan \phi_{di} \cos \alpha_i + \sin \alpha_i) - U_i \tan \phi_{di} + (H_{Li} - H_{Ri}) \times (\tan \phi_{di} \sin \alpha_i - \cos \alpha_i) + c_{di} L_i\right] \div [\cos \alpha_i - \tan \phi_{di} \sin \alpha_i] \quad \text{[L-1]}$$

Equation L-1 is the general wedge equation.